Limits of Hydrologic Alteration: A New Approach for Protecting Streamflows

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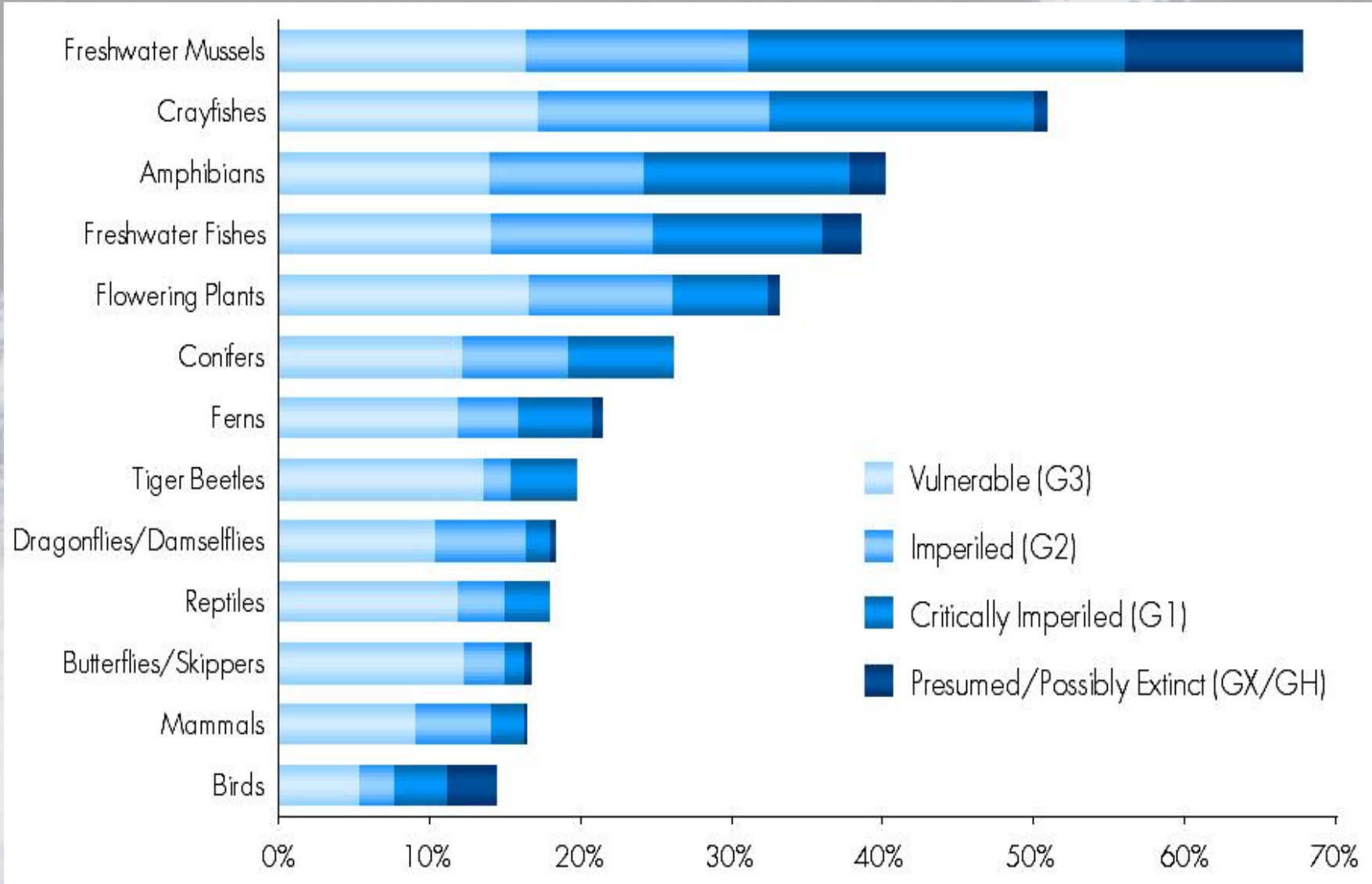
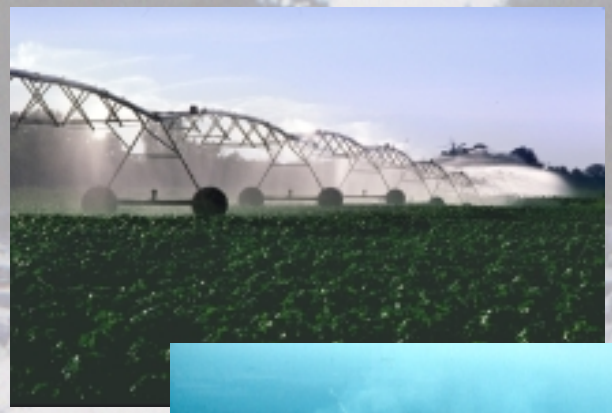
Proportion of U.S. Species at Risk



Freshwater Ecosystems

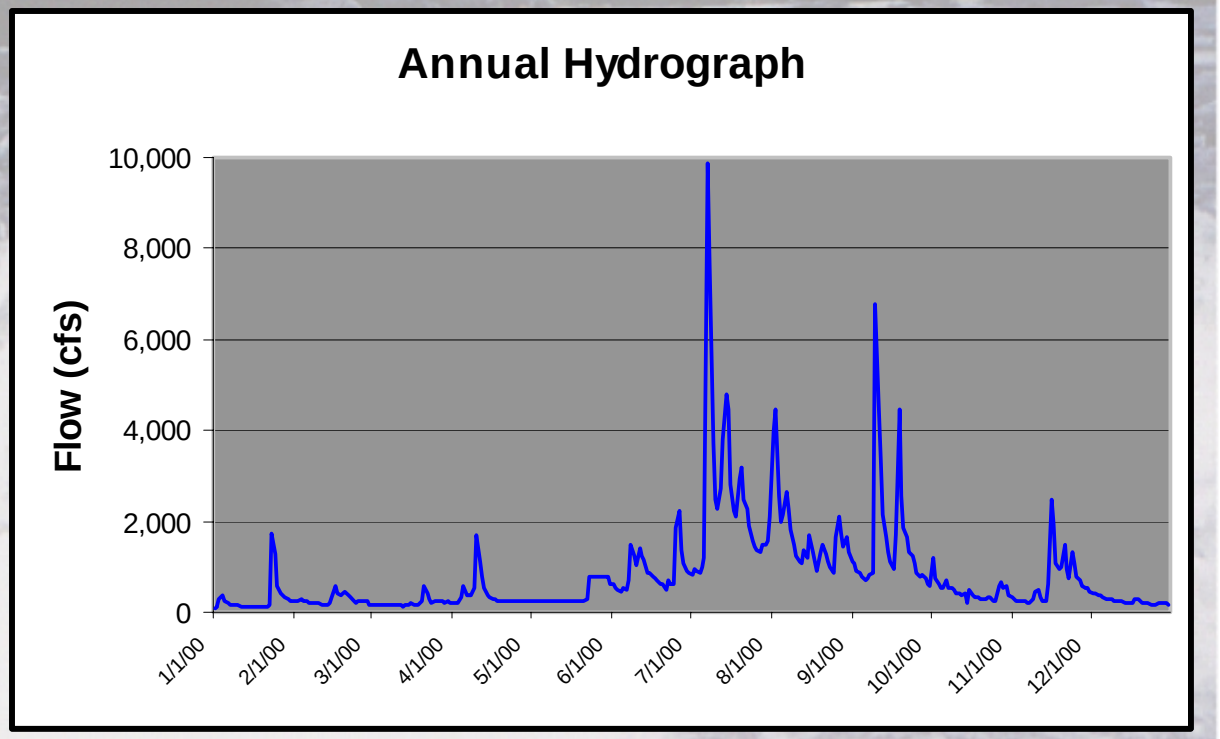
Causes of Species Loss...

- Water Quality Degradation
- Habitat Destruction and Fragmentation
- **Changes in Natural Flows**



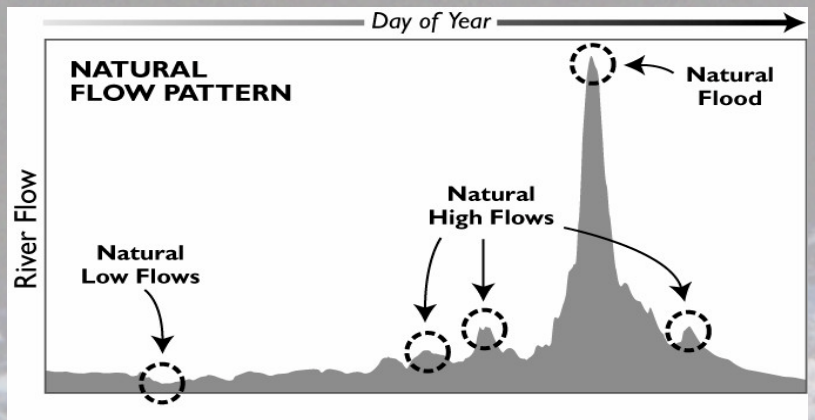
Hydrologic Regime

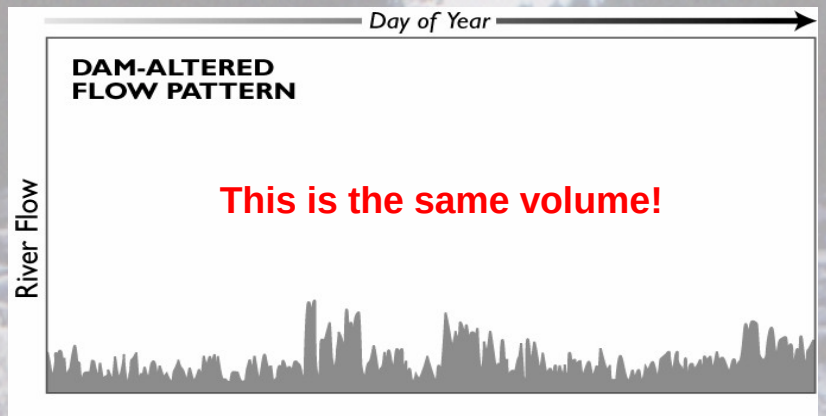
- ***Magnitude***
- ***Frequency***
- ***Duration***
- ***Timing***
- ***Rate of change***



➢ **Inter- and Intra- Annual Variability**

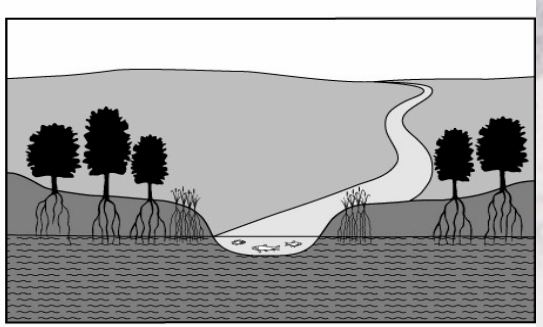
It's Not Just a Matter of Water Volume…





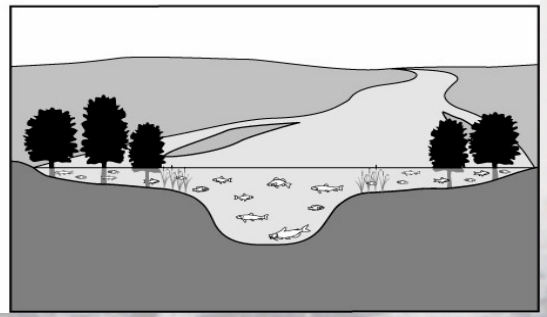
Natural Low Flow

- Fish have adequate oxygen and can move up- or downstream to feed
- Riparian vegetation sustained by shallow ground water table
- Insects feed on organic material carried downstream
- Birds supported by healthy riparian vegetation and aquatic prey



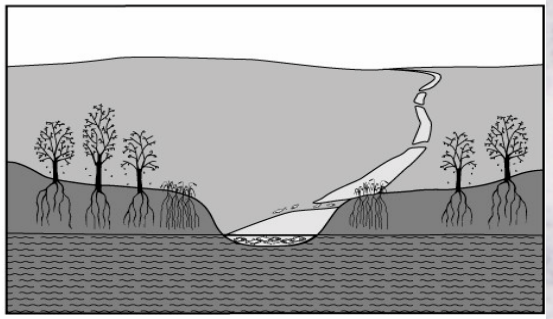
Natural Flood

- Fish are able to feed and spawn in floodplain areas
- Riparian plant seeds germinate on flood-deposited sediments
- Insects emerge from water to complete their lifecycle
- Wading birds and waterfowl feed on fish and plants in shallow flooded areas



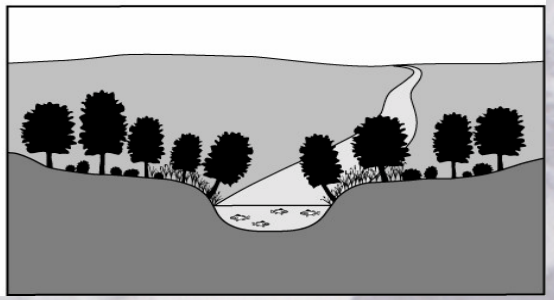
Inadequate Low Flow

- Fish are overcrowded in poor-quality water, cannot move to other feeding areas
- Riparian plants wilt when ground water table drops too low
- Insects suffer when water levels rise and fall erratically
- Birds unable to feed, rest, or breed in tree canopy



Absence of Flood

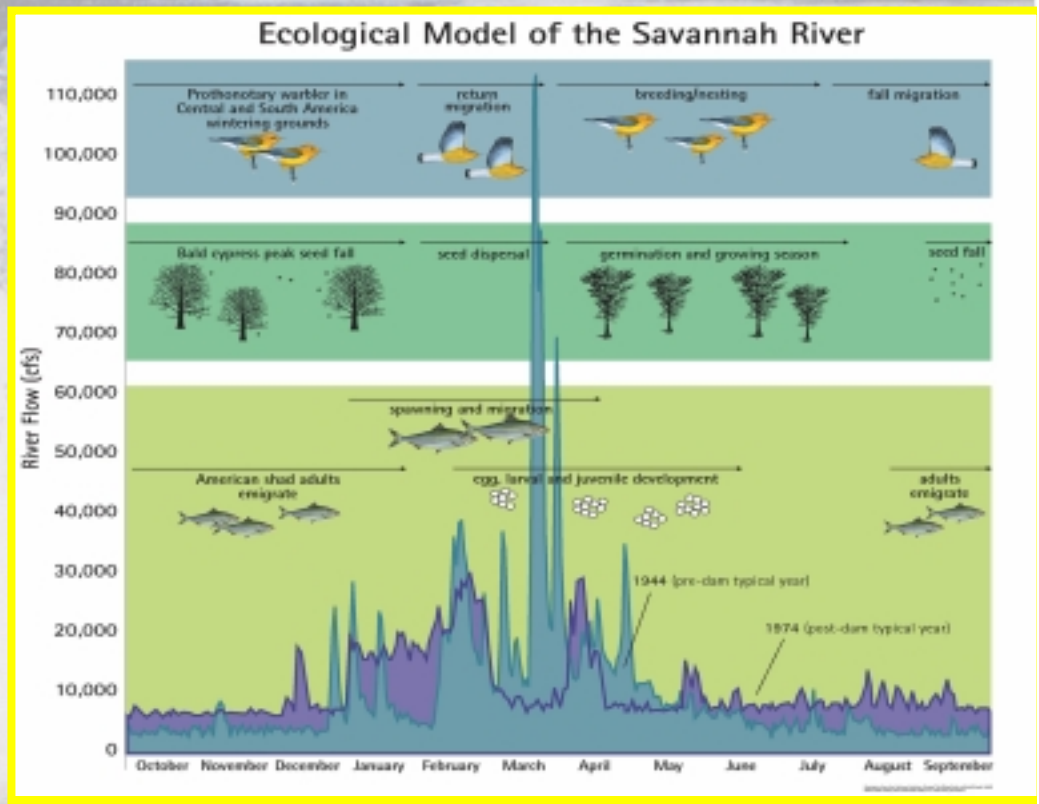
- Fish unable to access floodplain for spawning and feeding
- Riparian vegetation encroaches into river channel
- Insect habitats smothered by silt and sand
- Many birds cannot use riparian areas when plant species change



From: Rivers for Life: Managing Water for People and Nature, Postel and Richter

TNC Environmental Flows Principles

- **Restore and maintain the natural hydrologic regime and its natural variability to the greatest extent possible.**
  - **The goal is *not* to create optimal conditions for all species all of the time; rather, we want to create adequate conditions for all native species *enough* of the time**



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TNC and Environmental Flows

- **Developed IHA Software and RVA approach**
- **Sustainable Rivers Project**
- **EPA Funded Project on Water Supply Management**
- **Science Support for Eastern States on Instream Flows**

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Ecologically Sustainable Water Management

What's Missing in Water Quantity Management?

- **Clear management goals for our rivers that explicitly recognize the ecological need for variable flows**
- **State programs designed to achieve these management goals**
  - ***Permitting processes that are 1) ecologically protective; 2) balanced in sharing responsibility***

➢ **A systematic and efficient process for setting limits of hydrologic alteration across multiple rivers (e.g., state-wide)**

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Limits of Hydrologic Alteration (LOHA) Framework

LOHA is an approach founded upon three basic concepts:

- Environmental flow recommendations should be based on long-term ecosystem health, rather than single species management
  (e.g., Arthington *et a*l. 1992; Richter *et al*. 1997; Poff *et al*. 1997; Dyson *et al*. 2003; Annear *et al*. 2004)
- Ecosystem health is best supported by the natural flow regime, and departures from natural flows will result in ecosystem degradation
  (e.g., Arthington *et al*. 1992; Poff *et al.* 1997; Richter *et al*. 2003; Bunn and Arthington 2003; Annear *et al*. 2004)
- The health of rivers can be described as spanning a spectrum of degradation such as “excellent” to “poor”
  (e.g., Petts 1996; King *et al*. 2004; Richter and Postel 2003; USEPA 2004)

➢ **These river health classes can be used as a basis for goal-setting and applied to defining allowable flow alteration for all rivers in a state**

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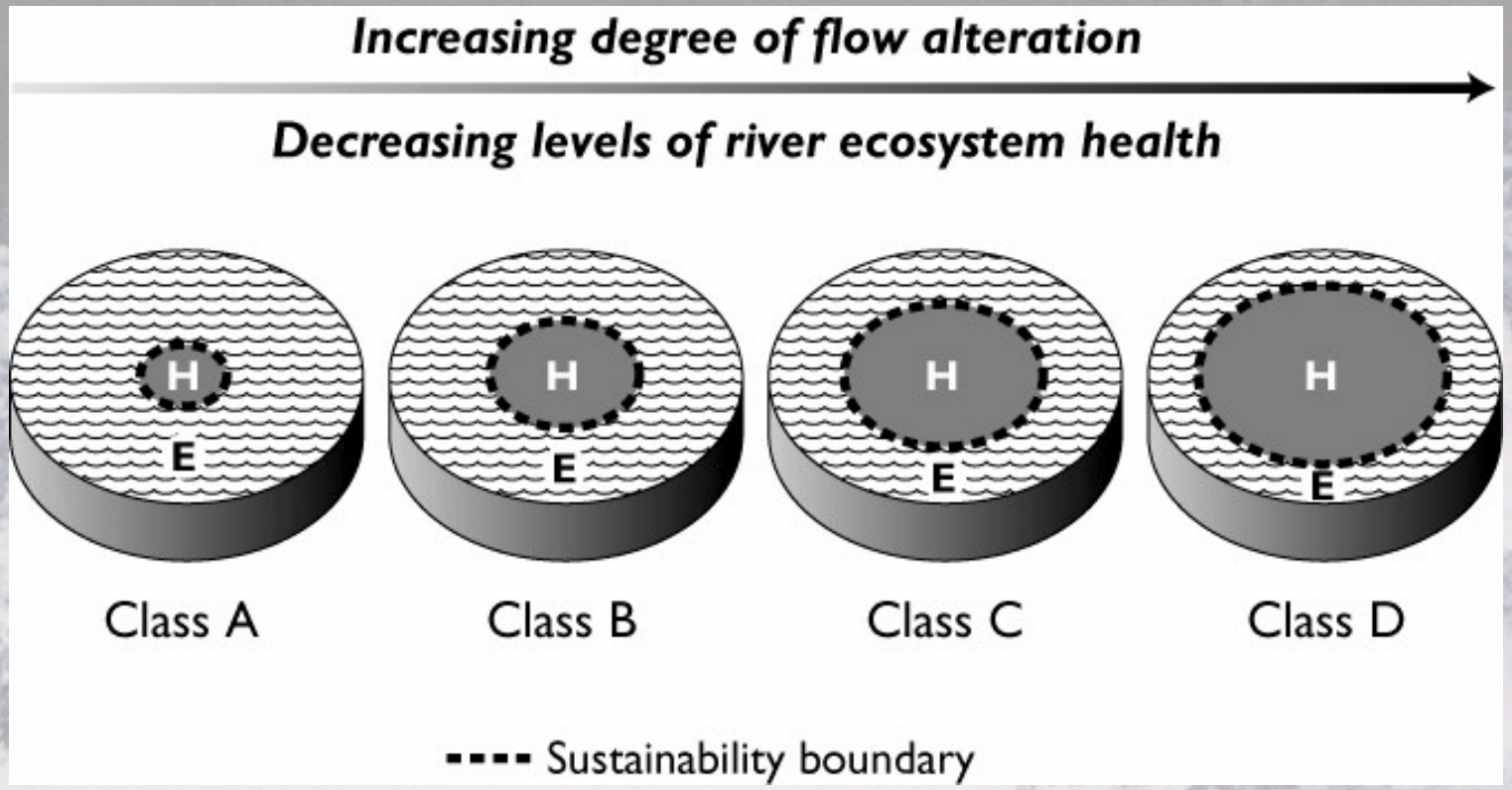
Ecological Goal Setting



From: "Rivers for Life: Managing Water for People and Nature"

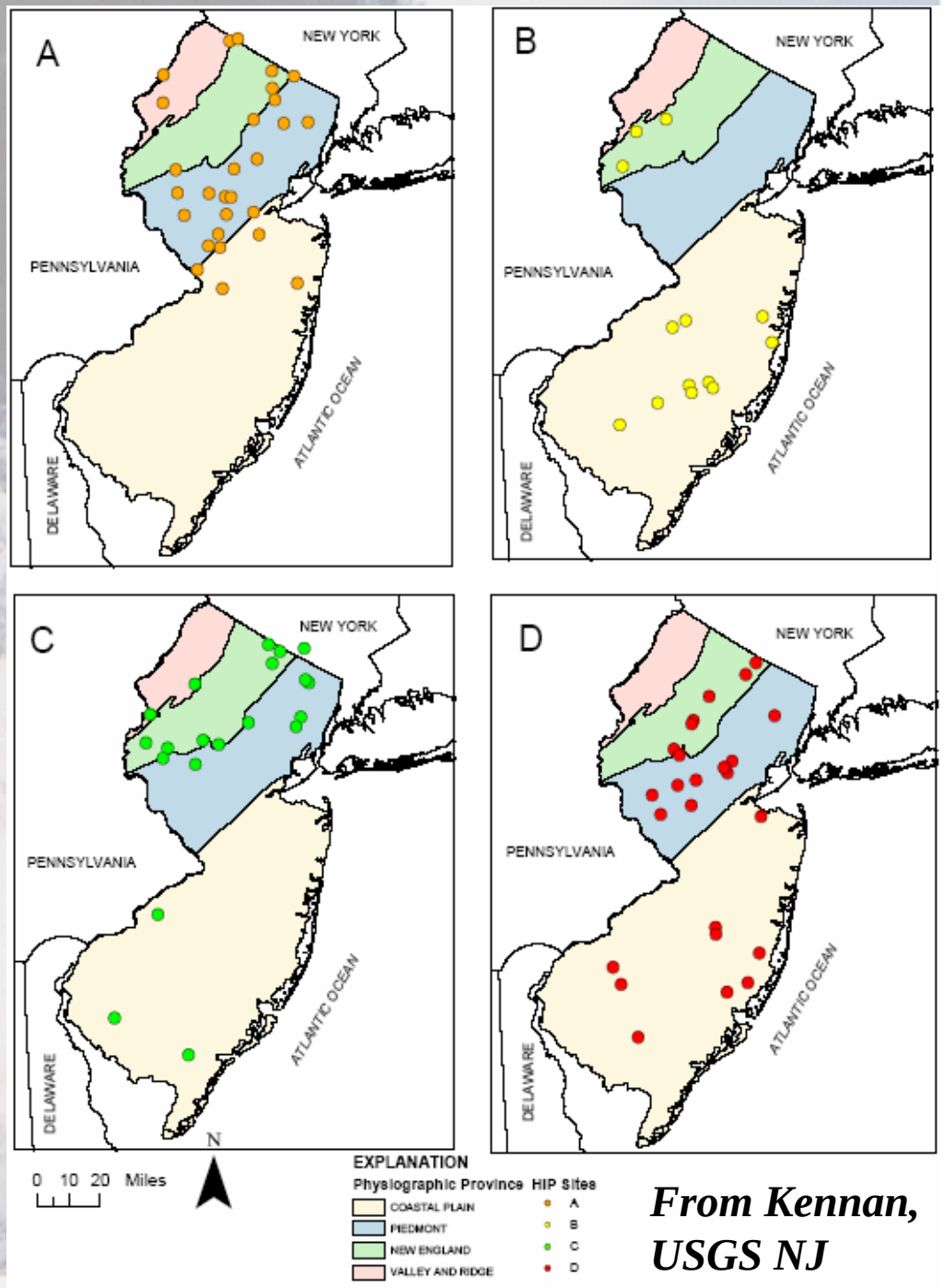
by Sandra Postel and Brian Richter (Island Press 2003)

LOHA Steps

River Classification: Separate rivers into types based on physiography, hydrology, and ecological characteristics: *one size does not fit all for management*

NJ Example:

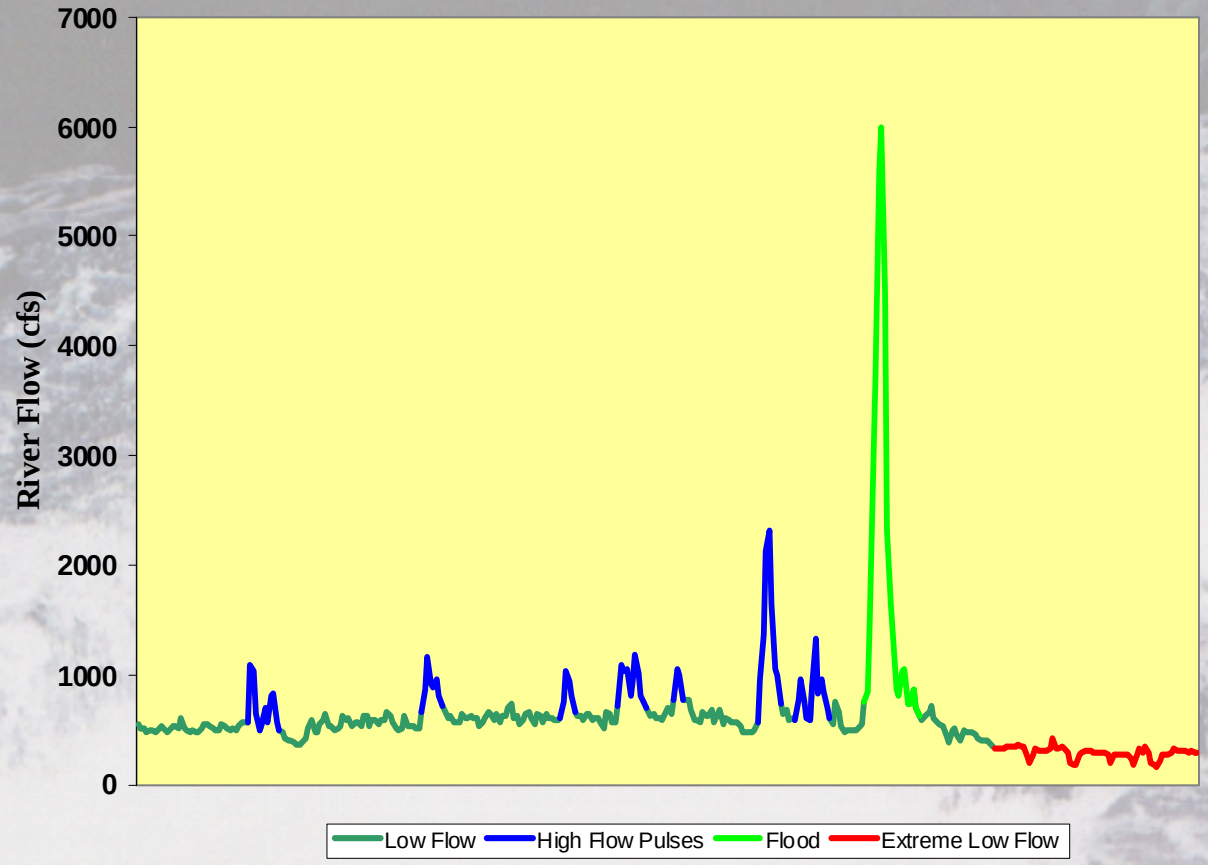
• Analyzed index gage flow regimes and determined 4 distinct hydrologic stream types which added detail to physiography



From Kennan, USGS NJ

Ecological Flow Components

Components include: extreme low flows, base flows, seasonal high pulses, small floods & floodplain maintenance flows



The natural hydrologic regime can be dissected into recognizable, repeating hydrograph patterns each of which play important ecological roles (Arthington *et al*. 1992; King and Louw 1998; Richter and Postel 2003)

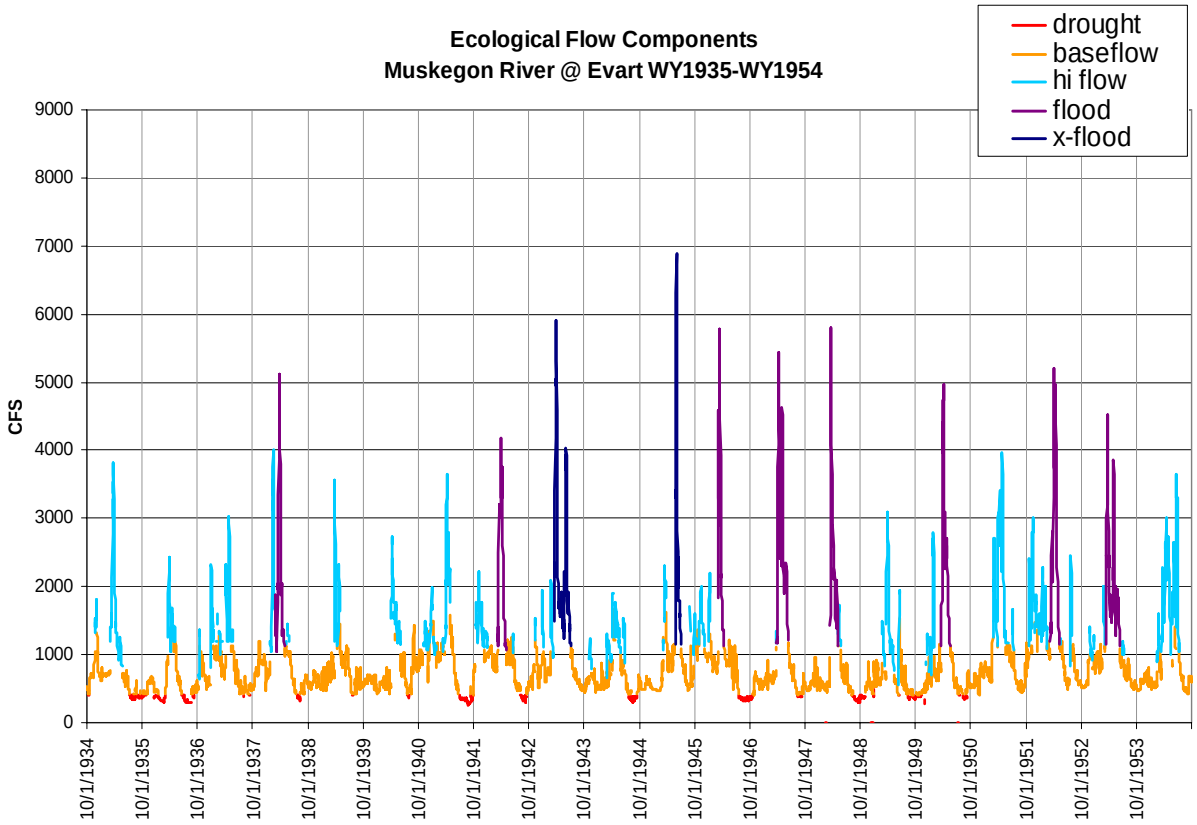
LOHA Steps

Hydrologic Characterization:

Define:

1) naturalized time series; and
2) current condition time series at major withdrawal points

Example: Texas Water Availability Model assesses natural flows, existing water allocations, and potential future allocation scenarios

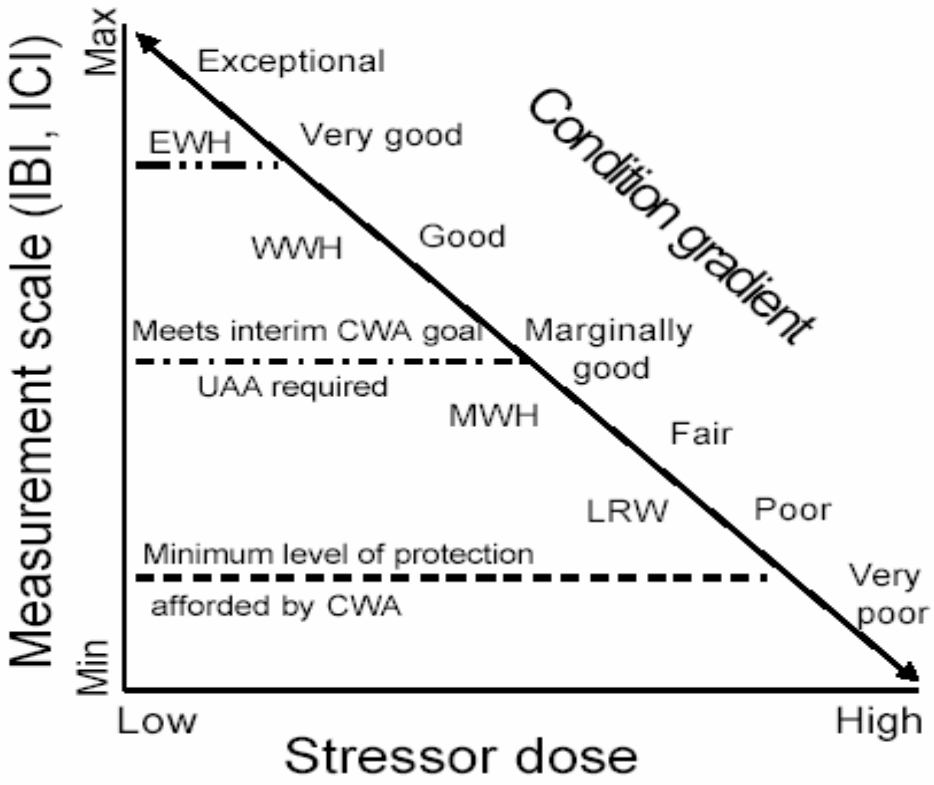


LOHA Steps

Establish a Biological Condition Gradient to Develop "Hydrologic Criteria"

- Flow alteration, like other stressors, can be generally quantified as having a gradient of impacts to biological condition

- This link can be made quantitatively, but also qualitatively, based on expert input and will likely vary based on river type.



From Karr and Yoder, in press

LOHA Template:

Relate ecological condition classes to an allowable degree of alteration

Ecological Condition Class	Description of Biological Condition	Limits of Hydrologic Alteration *(Deviation from reference condition for a hypothetical river type)*
1	***Native or reference condition***	Extreme low flow duration: < 5% Seasonal base flow magnitudes: < 10% High-flow pulse frequency: < 10% Small flood magnitude: < 10% Large flood magnitude: < 15%
2	***Minimal changes to biotic community***	Extreme low flow duration: < 10% Seasonal base flow magnitudes: < 15% High-flow pulse frequency: < 20% Small flood magnitude: < 25% Large flood magnitude: < 25%
3	***Moderate changes to biotic community***	Extreme low flow duration: < 15% Seasonal base flow magnitudes: < 20% High-flow pulse frequency: < 30% Small flood magnitude: < 40% Large flood magnitude: < 40%
4	***Severe changes to biotic community***	Extreme low flow duration: < 20% Seasonal base flow magnitudes: < 25% High-flow pulse frequency: < 50% Small flood magnitude: < 50% Large flood magnitude: < 50%

LOHA Method: Implementation

- **Set Goals: Assign Rivers a Desired Ecological Condition Class**

  Set health goals for rivers or river segments (i.e., tiered aquatic life uses)

- **Assess Compliance with Hydrologic Criteria**

  Criteria dependent upon the river's Class; flows assessed in relation to reference condition

- **Design Protection Strategies for Rivers Meeting Criteria**

  Analogous to water quality anti-degradation policies; facilitates review of new permit applications

- **Design Restoration Strategies for Rivers Out of Compliance**

  Analogous to TMDLs; facilitates watershed-based approaches for streamflow restoration

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